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Choking under pressure: theoretical models and interventions

Christopher Mesagno[1] and Juergen Beckmann[2]

In sport, choking under pressure is a major concern for athletes, coaches and sport psychologists because athletes fail to meet self-imposed performance expectations in critical situations (when it counts the most), which is devastating and embarrassing. Researchers have debated choking under pressure definitions, identified personality characteristics that exacerbate choking outcomes, and examined models to determine mechanisms for choking. Based on these investigations, several interventions to prevent choking have been developed and tested. In this review, we specifically discuss current self-presentation and attention models and theory-driven interventions that help to alleviate choking in order to facilitate the understanding of this complex phenomenon by athletes, sport psychologists and researchers.

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Choking under pressure (in sport psychology simply known as "choking") occurs when an athlete exhibits an acute, significant performance decrement in a competitive pressure situation, which is attributed to an increase in anxiety and when acknowledged by the athlete that self-expected standards would otherwise be achieved [1••]. Although a universal definition has been elusive to researchers (see Refs. [1••,2–4] for a choking definition debate), choking research has flourished since the classic, Baumeister [5] seminal choking study emerged. Researchers have tested personality traits of choking-susceptible athletes (*i.e.*, athletes likely to experience choking [6]), investigated neurophysiological correlates of choking [7•,8], analyzed and examined existing models of choking, and studied interventions to alleviate choking. We cannot provide an exhaustive review (see Refs. [9,10,11•] for full choking reviews), so we will focus on two areas: first, we provide an outline of current choking models to explain mechanisms, and next we discuss theory-driven (or theory-matched[1]) interventions to alleviate choking.

Explanatory choking models

Choking only occurs when there is an increase in anxiety under pressure [1••]. Since anxiety is essential to existing choking explanations, empirical research has either focused on the antecedents or consequences of the heightened state anxiety. Researchers have predominantly investigated attention-based explanations (*i.e.*, self-focus and distraction models), where choking occurs because the athlete alters (voluntarily or involuntarily) task-appropriate focus as a consequence of the anxiety increase. More recently, choking explanations have focused on the antecedents for why state anxiety intensifies under pressure. The self-presentation model is based on trait- and personality-inspired research to explain the origins of, and reasons, why some athletes are more susceptible to anxiety increases than others. As initially conceptualized (*e.g.*, [12]), researchers have argued that the self-presentation and attention models could be merged into one theoretical explanation, with the self-presentation model explaining the anxiety-exacerbating traits that may contribute to higher state anxiety levels and the attention models explaining why attentional shifts occur following the anxiety increase. Since this combined explanation has not yet been empirically tested (and is largely speculative), we discuss the self-presentation and attentional models as separate accounts of choking.

Self-presentation model

Fundamental to the self-presentation model is that certain personality factors predispose athletes to choking susceptibility (see Ref. [11•] for a review) and a greater propensity toward increased cognitive state anxiety. Mesagno [12,13] conducted research to indicate that self-presentation may be why anxiety intensifies under pressure, especially for athletes who possess choking-susceptible personality characteristics and are uncomfortable being in the elite sport 'spotlight'. Self-presentation is the process by which people attempt to monitor and control how they are perceived and evaluated by others

[1] We believe the terms theory-driven or theory-matched can be interchangeably used to illustrate when researchers (or practitioners) deliberately select a choking intervention based on specific theoretical knowledge the experimenter is testing (or understanding of an athlete's maladaptive cognitive processes).

[14]. Leary and Kowalski [15] explained that people engage in self-presentation as a means of creating their identity. Mesagno [12,13] argued that athletic identity (*i.e.*, the degree to which individuals identify with the role of an athlete [16]) is important in determining athletes' self-presentation concerns because competitions create worries about making a good impression. Self-presentation likely plays a significant role in choking because individuals attempt to create a public image that will support their preferred beliefs about themselves [14,17,18]. If athletic identity is under threat (*e.g.*, when performance is poor), then anxiety increases because of the possibility for sport-specific relational devaluation. Leary [18] explained that relational devaluation leads to increased social anxiety when impressions made will lead others to devalue or avoid relationships with them. If the athlete performs unsuccessfully they fear their public image as an athlete will be devalued. To minimize an anxiety increase, attentional shifts during high-pressure situations occur to possibly control for a devalued public image toward the goal of successful performance [12]. Empirically, Mesagno *et al.* [12] found that pressure situations that involve public evaluation increased athletes' anxiety and decreased performance more than motivational pressure manipulations. In a follow-up study, Mesagno *et al.* [13] found that individuals high in fear of negative evaluation (a positive correlate of self-presentation), compared to those low in fear of negative evaluation, exhibited choking with cognitive anxiety partially mediating the fear-performance relationship. Thus, the researchers [12,13] argued (albeit indirectly) that self-presentation exacerbated the choking experience.

Attentional models of choking

In sport, optimal performance occurs when attention is focused on sport-specific relevant information and processes, while concomitantly ignoring irrelevant cues [19]. Attentional models suggest that when anxiety increases, athletes divert attention to either internal (*i.e.*, movement-related or emotion-focused) or external (*i.e.*, environmental) irrelevant cues, instead of maintaining optimal attention. Researchers have formulated two attention-based models: self-focus and distraction.

Self-focus model

Advocates of self-focus approaches (*e.g.*, [5,20••,21]) believe choking occurs when the athlete allocates explicit attention to execution during heightened anxiety. Baumeister conducted a series of studies illustrating that increased self-awareness and pressure was detrimental to performance in an experimental and field-based study (*i.e.*, the Explicit Monitoring Hypothesis). Masters and co-workers [21,22] then found individuals trained in explicit motor learning (*i.e.*, given explicit instructions for skill execution) were more likely than those trained in implicit motor learning (*i.e.*, learning the skill with no explicit instructions) to 'reinvest' in explicit information when anxiety increased. Later coined, Reinvestment Theory [23••], implicit motor learners performed more automatically under pressure than explicit motor learners because explicit rules could not be accessed under pressure. Furthermore, Beilock and Carr [20••] investigated the accessibility of declarative (*i.e.*, formal, rule-based [24]) knowledge in golf putting as a product of skill development. Beilock and Carr found that experts had poorer episodic recollection than novices, which indicates that experts encode knowledge in a procedural form that supports performance without the need for constant attention. In their explicit monitoring hypothesis, Beilock and Carr argued that, for sensorimotor skills, anxiety instigates efforts to consciously control more complex, procedural knowledge that already operate outside of working memory. Drawing on these step-by-step procedures when executing expert, automatic behaviors essentially disrupts natural skill execution. Empirical evidence has also shown that adopting an internal focus on body movements instead of an external focus on the intended movement effect is detrimental to performance [25,26]. Overall, the self-focus model indicates that athletes experience 'paralysis by analysis' and constant attempts to control movement execution decreases fluent, coordinated movements processed by the brain.

Distraction model

Distraction based explanations (*e.g.*, [27–29]) of choking posit that as a result of heightened anxiety, attention shifts from task-relevant to irrelevant cues, which results in a neglect of important task-relevant information. As conceptualized in the distraction model [27,28], when worry and explicit self-instruction combine and exceed a threshold of attentional capacity, which limits the attentional space and allocation that enables high level performance. Some distraction (*i.e.*, Attention Control Theory [ACT]) models [29] have been discussed but are not specific to choking in sport, whereas other integrated models [30] have extended into sport research. That is, Nieuwenhuys and Oudejans' integrated anxiety and perceptual-motor performance model incorporates elements of ACT, information processing theory, and self-focus and distraction models of choking to explain breakdowns in skill execution. In doing so, Nieuwenhuys and Oudejans argue that the distraction and self-focus models can both be explained through distraction-based principles because anxiety shifts attention toward threat- and task-irrelevant stimuli (distinguishing among attention, interpretation, and response tendencies), which reduces available attentional space and compromises the processing of task-relevant information (see Nieuwenhuys & Oudejans, this special issue for further information). Nieuwenhuys and Oudejans argue that attention models are limited in their scope to explain the disruptive anxiolytic performance effects on movement execution and research should investigate breakdowns in performance

throughout the information processing stages of perception (*i.e.*, task-relevant detection) and selection (*i.e.*, decision-making about action possibilities) to advance choking theories.

From the reviewed attention models, evidence has advocated self-focus explanations (*e.g.*, [20••,31–33]) over distraction models with recent qualitative investigations (*e.g.*, [34,35,36•]) arguing that distraction-based explanations may have merit. Advocates of Nieuwenhuys and Oudejans anxiety-performance view may suggest that the equivocal research evidence between the self-focus and distraction models is due to the limited differentiation among perception, selection, and action within the choking literature. Further research should explore the perception and selection breakdowns of goal-directed action in order to distinguish suitable choking interventions beyond the theory-matched movement execution-based interventions (explained below). Mesagno and co-workers' self-presentation model and Oudejans and co-workers integrated model could also be combined and tested considering that threat-based cognitions are a common denominator. The main difference between these models is that Mesagno and co-workers posit that dispositional characteristics and antecedents lead to more susceptibility to increased state anxiety under pressure, whereas Oudejans and co-workers focus on the attention-based changes that result from the anxiety increase during choking.

Choking interventions

Understanding choking models cannot prevent choking, but it may help researchers and sport psychologists develop theory-driven interventions to minimize choking. Theory-driven interventions are techniques developed based on the choking model in which it is matched. Mesagno *et al.* [11•] argued that researchers should develop theory-matched (or driven) choking interventions especially for the supported self-focus and distraction choking models.

Self-focus based choking interventions

A central premise of self-focus choking interventions is to abate explicit knowledge and the conscious control of skill execution. Researchers have tested interventions to minimize the accrual of explicit knowledge during skill acquisition [37,38] or to divert attention away from self-focus in other ways (*e.g.*, [7•,33]).

Masters [38] initially suggested that analogy motor learning could be used to minimize the accumulation of explicit knowledge during skill acquisition. Analogy motor learning uses biomechanical metaphors to teach complex actions (*e.g.*, hitting a table tennis backhand as if 'throwing a frisbee' [38]). Liao and Masters [37] taught a table tennis forehand to novice players and found that the analogy motor learning group maintained performance under pressure and accumulated less explicit knowledge compared to an explicit motor learning group. The analogy and explicit learning groups were similar in learning indicating analogy learning is a good method of skill development with pressure resilience benefits, which has been replicated [39].

Since skilled athletes may have already accumulated explicit knowledge, researchers also developed interventions to divert attention away from self-focused attention and to reduce reinvestment. Initially, researchers [21,32] found that using a dual-task paradigm under pressure could reduce self-focusing. Mesagno *et al.* [33], however, explained that athletes may not use dual-tasks because of the limited practicality for performance under pressure and perceived as a distraction from task-relevant focus. Thus, in a single-case research design [33], athletes focused their attention on the words of a song and the results indicated that using music as a dual-task alleviated choking in basketball free-throw shooting. One final novel, behavioral intervention to divert attention away from self-focusing is brain hemisphere priming. Theoretically underpinned by self-focus models of choking where left brain activation is dominant under pressure, Beckmann *et al.* [7•] suggested that hemisphere priming through squeezing a ball with the left-hand would reduce conscious control. Recent studies [7•,40] have indicated that left hand-ball contractions prior to skill execution eliminates choking, which Cross-Villasana *et al.* [41] found is due to relaxation spreading across the brain and reducing activation in the critical left brain hemisphere regions.

Distraction-based choking interventions

The purpose of distraction-based choking interventions is to eliminate internal or external distractions in the hope of promoting a sport-specific relevant focus of attention during execution. One sport psychology intervention that helps to improve task concentration is a pre-performance routine (PPR). A PPR is a sequence of task-relevant thoughts and actions an athlete systematically engages in prior to performance of a sport skill [19]. Mesagno and co-workers [6,42] conducted a single-case design study with three 'choking-susceptible' athletes and then a follow-up experimental study to determine if a PPR helps maintain performance under pressure. In both studies, Mesagno and co-workers found that an extensive PPR (featuring cognitive and behavioral preparation, deep breathing, and cue words) helped athletes maintain (single-case design study) or improve (experimental study) performance under pressure compared to low-pressure phase scores or a control group who did not receive PPR education, respectively. Furthermore, the experimental design also indicated that single elements of a PPR (including PPR temporal consistency; time to complete the routine before skill

execution) helped to improve performance under pressure compared to a control group who did not receive PPR education. Thus, it appears that inclusion of task-relevant cues or consistency of the PPR helps alleviate choking.

Researchers have found that quiet eye (*e.g.*, [43]) and acclimatization [44,45] training are theory-inspired (by ACT) interventions that alleviate choking. Quiet eye (QE) is defined as the final visual fixation toward a relevant target prior to the initiation of a movement [46]. QE training (*i.e.*, practicing longer visual fixations on a target before initiating a movement) is a specific method to improve task-relevant visual focus. In a classic study, Wood and Wilson [43] investigated whether QE training could improve the visual attention control and aiming of experience soccer players on penalty taking. Wood and Wilson found, during baseline and retention tests, the QE training group exhibited better visual attention control, were more accurate, and had fewer shots saved by the goalkeeper than a control group. During a 'live' shootout, however, the QE training group's accuracy advantage was not maintained over the control group, which may indicate its limited utility for real-world application on one-shot penalty taking attempts.

Furthermore, acclimatization (also known as self-consciousness or simulation) training is when athletes adapt to increased anxiety by practicing with some anxiety present [44]. Acclimatization training is based on the principles of ACT whereby investing more mental effort may prevent the negative effects of anxiety. Apparently, training with anxiety improves the self-regulatory processes involved with investing increased mental effort and thus reduces choking (*e.g.*, [45,47]). A seminal study on acclimatization training found that training under mild anxiety over a 5-week intervention improved basketball free-throw and dart throwing performance in two separate experiments [44]. This has also been replicated in police officers [47], although more recent research within sport may indicate null effects [48].

Within this review, these interventions have been categorized into their respective theory-driven interventions based on the authors' perceived theory-driven views (*i.e.*, the authors of the papers interpretation of how the intervention fit into choking models). We believe that some of these interventions could be used as theory-driven interventions for both attention-based choking models. For example, within QE research, investigators originally intended QE techniques to be a method of improving task-relevant focus based on ACT (*e.g.*, [43]) and then offered research support as a self-focus model intervention to help novice athletes (*e.g.*, [49]). Nevertheless, all of the interventions reviewed had generally positive effects as choking interventions irrespective of their theoretical basis.

Future research

Researchers have struggled with a global definition of choking since Baumeister [5] defined it as performance decrements under pressure. We believe focusing on performance as a defining element may be one of the problems because performance is determined by a number of factors beyond the control of the actor (*e.g.*, other competitors' ability), which may intensify the use of the choking label. When performance is the only indicator of choking, then incorrect labelling of a choking incident could occur when an athlete in a competition exhibits a personal best in skill execution but shows a mediocre placing due to exceptional competitor outcomes. What is important, when labelling performance as choking, is the breakdown of the 'internal mechanisms' of motor skill that can be measured through motor control specific outcomes. Recent neurophysiological research in choking supports self-focus explanatory models. With increased automaticity there is an increase in neuroefficiency [50], yet, under pressure brain areas involved with reinvestment disrupt the flow of expert skill execution resulting in increased kinematic variance that may produce significant deviations from normal performance. Neural imaging techniques (such as brain mapping with EEG, fMRI, rTMS [8,51]) open new avenues for understanding the mechanisms underlying choking. Furthermore, continued use of eye tracking (*e.g.*, [44,49,52,53]) and electromyography (EMG; [54,55]) to measure visual search and kinematic outcomes under pressure is crucial for the advancement of choking research in sport.

Conflict of interest statement

Nothing declared.

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